Bushfire Frequency and Vegetational Change in South-eastern Australian Forests

By N. A. Wakefield*

Introduction

The article deals primarily with certain forested Crown lands in the northern part of East Gippsland, Victoria. The area concerned is bounded by the Great Dividing Range on the west, the New South Wales border on the north, the Snowy River on the east, and a line approximately from the Little River-Snowy River confluence through Mount Seldom-seen on the south. The tract embraces some 250,000 acres, or a little over 400 square miles.

The elevation at the Snowy River is about 600 feet and at the Cobberas Mountains about 6,000 feet. The topography is complicated, with deep river valleys intersecting areas of mountain ranges and plateaus. Mean annual rainfall is from approximately 20 inches in the Suggan Buggan valley to over 40 inches about the Dividing Range. Due to variations in soil, precipitation, elevation and aspect, there is a mozaic of different vegetational formations. Of those in the tract which has been defined, the following will be commented upon in this article:

(a) *Peppermint Forests.* These occur mainly in the valleys of the Buchan River and its tributary the Reedy River. (The latter is called "Reedy Creek" on some maps.) They occupy more-or-less steep stony slopes on the warmer aspects, and the dominant trees are Broad-leaved Peppermint (*Eucalyptus dives*) and Brittle Gum (*E. mannifera*). In some places there is, in addition, some White Sallee (*E. pauciflora*) and/or Candlebark Gum (*E. rubida*). The main grasses are *Danthonia* spp. (e.g. *D. pallida*), *Poa* spp. and *Themeda,* but grass is a minor element in comparison with the great bulk and variety of woody shrubs.

(b) *Gum Forests.* The Wulgulmerang Plateau, at about 3,000 to 4,000 feet elevation, and neighbouring areas, carries mixtures of White Sallee (*Eucalyptus pauciflora*), Candlebark Gum (*E. rubida*) and Mountain Gum (*E. dalrympleana*). In general there is a medium to thick ground cover of coarse grasses† (*Poa* spp., *Danthonia* spp. etc.), which intermix with sedges in flat wet places. On comparatively dry slopes, especially rocky ridges, there are some patches of shrubbery (*Pultenaea juniperina, Daviesia* spp., *Acacia dealbata* etc.).

(c) *Box Woodlands.* The lower parts of the valleys of the Snowy and Suggan Buggan Rivers, up to approximately 2,500 feet elevation, carry an open woodland of White Box (*Eucalyptus albens*) and fine grasses, mainly *Danthonia* spp., *Poa* spp. and *Stipa* spp.). On some of the northerly and westerly slopes the eucalypts are replaced by cypress-pine (*Callitris columellaris*); and steep more-or-less rocky hillsides carry Red Stringybark (*E. macrorrhyncha*) and coarser grass (mainly *Poa*).

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† Despite the coincidence of genera, the actual species of grasses are generally different in the different forest formations discussed.

History of Cattle Grazing and Burning

Cattle were first pastured in the Suggan Buggan valley in 1843, and from 1845 onward the Wulgulmerang area was used for grazing by members of the O'Rourke family. Soon after the turn of the century, properties at Black mountain and Wulgulmerang were acquired by J. C. Rogers, and he and members of his family have grazed cattle, in the area defined in the above introduction, for the past 68 years. Usually the forest grazing involved about 300 to 500 Hereford cattle.

A general outline of burning practices and their effects on vegetation has been provided by K. C. Rogers, a grazier living in the Black Mountain area, in these terms (letter, 30/8/1969):

My father came to Black Mountain in 1902. In those days John O'Rourke of Wulgulmerang and others used to tell of the open, clean-bottomed, park-like state of the forests of this tableland and adjacent areas, which they could well remember from earlier days. The Pendergasts of Benambra, whose cattle runs adjoined ours at the Dividing Range, told the same story. Over a period of years, before we came to the district, it had been the accepted thing to burn the bush, to provide a new growth of shorter sweet feed for the cattle.

As soon as we boys were old enough, we were keen to do the burning. The practice was to burn the country as often as possible, which would be every three or four years according to conditions. One went burning in the hottest and driest weather in January and February, so that the fire would be as fierce as possible, and thus make a clean burn. As a general practice, in the valleys, we would light along the rivers and creeks, so that the fire would roar up the steep slopes on either side, making a terrific inferno and sweeping all before it. The hotter the fire, the sweeter and better the feed for the cattle after the new growth came. The tablelands received special attention, for the high country, though more tedious to burn, provided the most feed. Should a wet summer occur, the burning programme was all the more important the following year.

In short, the run-holders, until regulations prevented, would consistently burn the bush as often as possible. The only area where this procedure did not apply extensively was the White Box country of the Snowy River and Suggan Buggan valleys, for the grass there was sweet without fire. It would seem that the long-followed practice of regularly burning the bush in the hot part of the year has resulted in a great increase of scrub in all timbered areas except the box country. The latter does not burn readily, even if fired, and the forests of White Box remain clean in the bottom.

That poses another question, regarding the great abundance of the younger group of cypress-pines in the valleys of both rivers, where there are only a scattered few of a much older generation of pines amongst the vast majority of the younger ones. In this case it is hard to credit that fire has been the cause of such an increase in pine population, since they are growing adjacent to, or in association with, the White Box timber. The stands of the younger pines were, to my knowledge, about the same in density and distribution 60 years ago as they are today, but I remember them first as much smaller trees.

During later discussion with Rogers, the following specific details were summarized with regard to vegetational growth after firing:

(a) *Peppermint Forests*

Fire cleared all minor vegetation and, when particularly severe in steep areas, it burned foliage and small branches completely off the trees. Within a few months *Eucalyptus dives* coppiced from the butts and on trunks and limbs. *E. mannifera* developed shoots on trunks and limbs but less at ground level. There was vigorous regrowth of ground vegetation, (mainly from root stocks) comprising shrubs, herbs and an abundance of grass of many species (including some annuals). Seeds of shrubs, especially *Olearia, Cassinia* and *Heli-*

chrysum, germinated, as well as those of most eucalypts. *E. rubida,* when present, germinated very prolifically in areas of fierce fire. After years of firing, *E. dives* formed dense thickets due to its ability to coppice after fire. Almost impenetrable peppermint scrubs have become quite a feature along ridge tops of the steep Buchan River valley.

Grass was most palatable to cattle during the season (spring and summer) following a fire. *Danthonia pallida,* for instance, provided good grazing at first but leaves hardened after 18 months (hence the local name "wire grass").

By 3 years, shrubbery had matured and ceased growth, grass coverage was smothered and reduced in bulk, and the eucalypt scrub was about 7 or 8 feet high. At this stage, the area was reburnt. (Burning was rotated, so that a third or more of the forest was burnt each summer when conditions permitted).

(b) *Gum Forests*

In general, an area would be burned over about every four years, but some parts, for example those adjacent to the Black Mountain properties, were generally burned at 3-yearly intervals. Fires were usually not fierce, but occasional fierce bursts occurred, especially on the rougher terrain. Grass was burned back, shrubs and eucalypt scrub killed to ground level, and wattle scrub often killed completely. By the following spring there was regrowth of grass and shrubbery from the rootstocks, eucalypts had coppiced, and seedlings of eucalypts and wattles had appeared. Eucalypt germination, especially of *E. rubida,* produced dense crops in areas of fierce burns. In some areas *Acacia dealbata* formed dense scrubs after fires.

Grass remained palatable and continued to grow through the second spring-summer season also, but after two years showed little or no further increase in bulk. The *pauciflora-rubida-dalrympleana* association was, and still is, on the average, much more grassy and less scrubby than the *dives-mannifera* association.

The escarpment which faces southerly on the northern side of the Reedy River valley provides a conspicuous example of the development of scrublands as a result of firing. Originally there was a well-grassed clean-bottomed forest, mainly of *Eucalyptus dalrympleana* but with some *E. rubida.* It is now an area of dense scrub.

(c) *Box Woodlands*

In general, the country is not susceptible to fire. Lightning fires seldom travel far, except in steep country. During the past 60 years, no fire has burned down into the more open and level parts of the Suggan Buggan valley, not even the fiercest ones that have swept the surrounding forests.

No attempts were made to fire the open Box Woodlands, but some burning was done on the rougher slopes of *Eucalyptus macrorrhyncha,* on adjacent steep slopes of *E. albens,* in rough creek heads, etc. Such burning generally resulted in marked development of scrub (*Eucalyptus, Helichrysum conditum, Cassinia* spp. etc.), and any further burning that was done tended to increase this shrubbery.

Feral and Native Mammals

Rabbits

In the latter part of last century, the O'Rourkes used to run several hundred head of cattle, mainly in the Box Woodland areas of the Suggan Buggan and Snowy River valleys. Rabbits appeared in the country about

the turn of the century and quickly reached plague proportions. Hares were numerous up to that time but then disappeared within a few years to the level of extreme rarity. The development of scrub had progressed in the forests (as distinct from the Box Woodlands) before the rabbit came, but not to the extent that it has during the present century.

Rabbits did not become abundant enough in the forest areas to have significant effects on the vegetation, but in the Box Woodlands they became very numerous and more-or-less denuded the ground of herbage. The stock-carrying capacity of the woodlands was decreased to about one-tenth its earlier level.

In 1948, the writer noted that, although numerous tiny seedlings of *Callitris* could be found in the Suggan Buggan area, there were no specimens whatever between that stage and the small trees estimated at about 50 years of age. Since the advent of myxomatosis, in 1952, and the resultant reduction of the rabbit population, there has been a significant survival of *Callitris* seedlings and many of the young plants are now some feet in height. The conclusion is that *Callitris* germinates freely without fire but that subsequent survival and growth is contingent upon lightness or absence of grazing. According to ring counts and measurements of girth, the scattered specimens of old *Callitris* trees range in age from about 100 to 250 years.

Following reduction of the rabbit population, grass growth has increased again in the Box Woodlands.

Wild Horses

These have usually been present in some hundreds in the area under discussion. They are highly mobile and more nomadic than cattle, and move in force on to recently burned areas, to eat the new grass growth. They crop the herbage closer than cattle do, and thus can feed on shorter and sweeter grass, such as much of that on the subalpine meadows. In summer they concentrate on the snow grass on the high mountains, whereas cattle usually graze there only after it has been burned, and that is very rarely.

Kangaroos and Wallabies

The Grey Kangaroo (*Macropus giganteus*) is scattered but uncommon in the *dives-mannifera* association; it is more numerous on the plateaus in the Gum Forests. Originally, kangaroos were rare on the higher plateaus but are now not uncommon at 4,000 feet and higher. They are plentiful on the fringes of cleared paddocks, which they enter at night to graze on the improved pastures. In the Box Woodlands their numbers have varied in inverse proportion to those of the rabbit populations.

The Brush Wallaby (*Macropus rufogriseus*) appears to be more numerous now than it was originally. It favours drier slopes of the *dives-mannifera* association (living in eucalypt and *Daviesia* thickets) and the more scrubby Gum Forests of the lower plateau country.

Discussion

The writer, while living and working in various East Gippsland localities from the 1920s to the early 1950s, has been acquainted with the practices of graziers in the region and has made both general and particular observations of the vegetation. The history of very frequent firing of forest areas and the change from comparatively open formations to more scrubby vegetation, as described by Rogers, has applied in general to the dry sclerophyll forests throughout

East Gippsland. Various other species of eucalypts have been involved, but patterns have been similar. There is evidence also that development of scrubby forests in south-eastern New South Wales and in other parts of Victoria has been associated with high frequency of bushfires.

Graziers' fire practices in New South Wales, over 140 years ago, are described by P. Cunningham (*Two Years in New South Wales,* vol. 1, pp. 211-2; 1827):

> The old withered grasses are usually burnt off in the spring, and often at other periods of the year if you have an extensive run for your stock; and it is astonishing to see how quickly and how luxuriantly the new grass will push up after these burnings, if a shower of rain should happen to follow them. When judiciously accomplished, they certainly produce most beneficial effects, by destroying all the old grass which the cattle and sheep refuse to eat, and which is therefore only a bar to their feeding.

The last sentence of the quote conforms to the parts of Rogers' data which note that in the forest areas over-mature grass is not readily eaten by stock. In this connection it is relevant that virtually all the more open forests in south-eastern Australia were included in the runs leased to the original squatters, and that, subsequent to that era, most of the forests were again leased more-or-less continuously to graziers. Consistent rotational burning was necessary in these grazing leases to keep them functional from the graziers' point of view.

There has been much consideration recently, by foresters and other interested persons, of the problem of fuel accumulation in southern Australian forests, and of the question of the use of mild burning, in suitable weather conditions, to reduce this fuel and thus minimize the risk of very destructive wild fires in the forests concerned. When endeavouring to establish an historical background to the problem, authors of addresses and documents on the subject usually advance the hypothesis that the widespread change from open grassy forests to dense scrubby formations has been due to *infrequency* of fires during the era of European settlement in Australia, as compared with the (postulated) high frequency of aboriginal fires. As far as sclerophyll forests are concerned, such histories as that given by Rogers indicate that this hypothesis is the opposite of actual fact.

As regards East Gippsland, and evidently elsewhere in south-eastern Australia, the salient points are (i) that for about a hundred years there was a regime of rotational burning, at 3-4 year intervals, of many or most areas of dry sclerophyll forest, and (ii) that during this regime there was marked increase in shrubby undergrowth in these forests. It is significant that such evolution of scrub occurred in areas subjected to maximum possible fire frequency. This appears to demonstrate, conclusively, that the more grassy and less scrubby forests known to the earliest settlers were *not* a deflected climax due to high fire frequency but were, on the contrary, a state of vegetation associated with comparatively low fire frequency.

It should be noted that these comments are applied to dry sclerophyll forest formations, not to woodlands or wet sclerophyll forests. The main areas of Box Woodlands of north-eastern Gippsland have not had a known fire history nor have they been involved in the problem of accumulation of scrub and other dangerous fuels. The wet sclerophyll forests of Victoria, notably those dominated by *Eucalyptus regnans,* have

had quite different histories — in this case involving comparatively infrequent but very devastating fires.

It should be noted also that, in general, the regime of high fire frequency in the dry sclerophyll forests of Victoria terminated some 20 years or more ago, with the introduction of certain legislation, the implementation of stricter fire prevention measures, and the development of more sophisticated access and fire fighting facilities. During the past two decades, over-mature scrub and dead fuel have tended to accumulate, and there have been some very destructive accidental wild fires, such as those which swept the Wulgulmerang area and neighbouring parts in 1952 and 1965. It is this kind of episode which necessitates the consideration of systematic fuel reduction by controlled burning.

The point which this article seeks to emphasise, that the increase of scrubby undergrowth in our dry sclerophyll forests was associated with *high* fire frequency, is of academic rather than practical importance. The forester's practical problem is to determine how to reduce the inflammability of the present scrublands, irrespective of the factors which caused their development. The matter of cause however has bearing on the question of aborigines' use of fire and the frequencies of fires in various formations in Australia in the pre-colonization era. It is proposed to consider these latter aspects in a further article on bushfires in the near future.

Appendix

A draft of the foregoing article was submitted for criticism to certain persons who are actively concerned with problems of forest fires, and those persons made the following suggestions:

(a) That the burning carried out on the Rogers run had *not* in fact been as frequent as stated, that fires burning in 3-year-old fuels would *not* "roar up the steep slopes", etc., and that such effects would have been observed instead in fuels not burned for probably six years or longer.

(b) That, while mild fires at 4-year intervals (and in some places longer) would be likely to change a clear forest floor into a scrubby one, this did not negate the theory that many "clear" forests of the dry sclerophyll types were due to more frequent fires.

(c) That if two, three or even four fires occurred in quick succession on an area, then those shrub species not able to survive by root stock or seed supply would be substantially reduced and it would take many years for them to recolonize the area, regardless of fire frequency after the "quick" fires.

After examination of these criticisms and comments, Rogers replied as follows (letter, 10/11/1969):

> I can only stress the accuracy of the statement that we burned the bush *as often as possible*. Naturally there were seasons when burning could not be done, so that there were instances when certain areas missed out on a burn for six years or more. These naturally were the places that carried the greatest infernos if in steep country, and such fierce fires tended to produce the worst scrub. On the other hand, we burned a lot of the bush every three years.

No bushland in this area would ever burn extensively if fuel were only one or two years old. A vivid example of this was in the great 1939 fire which, after burning Omeo, raced on eastward on Black Friday as far as the high exposed ridge known as Fish Creek Top. There the fire was intense and the branches were burned off the trees, whilst in the Fish Creek valley, immediately below and on the east side, we later observed that burning air-borne debris had started numerous small spot fires which had then gone out. We had burned out that valley and most of the area eastward to this property two years previously, thus saving our home area from the blaze despite the terrible conditions that day.

At three years, if conditions favoured in January and February, fire would sweep over certain areas such as the Buchan River valley at quite a pace, owing to the quantity of dry grass with the scrub. We would also burn a lot of the tableland area, of 3000 to 3500 feet elevation, which surrounds our property, every third year, though this gum forest country is less burnable than the peppermint slopes. Indeed, one summer a number of years ago, during a heat wave, the whole of the tableland along and southward of the Rocky Range, and embracing the heads of Omeo Creek, carried a spectacular fire several miles in extent and severe enough to kill the forest of *E. dalrympleana* and *E. pauciflora*. I can vouch for the fact that the same area was all burned three years previously. However, the top shade temperature that day was 98°, which is quite exceptional for this altitude, and there was a high north-westerly wind with it.

It will be seen from the above details that we indeed carried out "saturation burning", if that term means burning as frequently as possible. It is also evident to me, from results observed, that burning every three years still produces scrub. Most young eucalypt seedlings sprout from the stock when the top is killed by fire. There is also an inexhaustible supply of seed in the ground, which is helped by fire to germinate from burn to burn. This seems to apply to nearly all native plants. That is why scrub now infests the forest floor throughout the tablelands and gorges.

The criticisms and Rogers' further comments, which comprise the foregoing part of this appendix, appear to confirm the earlier contention that, in general, a regime of maximum fire frequency was maintained in the forests in question and that this regime progressively increased the scrubbiness of the forests. This leaves unchanged the conclusion that fires due to lightning and aborigines were collectively less frequent than those during the era of colonization.

As regards the hypothesis that scrub may be eliminated by very frequent fires, it should be noted that *Cassinia, Helichrysum* and *Olearia* species flower and produce their first crop of seeds from 24 to 30 months after germination, and that large shrubby fireweeds (*Senecio* spp.) seed at 12 to 18 months. Therefore, if fires are to eliminate these species by preventing them from seeding, the habitats would need to be burned regularly at 2-year intervals in the case of the first group, and annually in the case of *Senecio*. A regular 2-year fire frequency is certainly not possible in East Gippsland forests and is probably not possible in any of our dry sclerophyll forests.

Rogers' inference that the supply of seeds in the ground does not become exhausted despite a series of germinations, is evidently quite valid. In various parts of Victoria it has been noted that areas which have been bare of shrubs for decades, because sheep and rabbits have eaten all seedlings which have been growing over the years, will produce a cover of native shrubbery when those grazing animals are excluded.